

DOLLAR and ENERGY SAVING LOAN PROGRAM

FINAL SAVINGS ANALYSIS Omaha Area Pilot Study

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Nebraska Energy Office

Table of Contents

Introduction	2
Assumption and Methodology	3
Impact on Natural Gas Consumption	5
Impact on Electricity Consumption	7
Effect of Gas Furnace Projects	8
Effect of Efficiency of Furnaces Installed	11
Effect of Air Conditioner Projects	14
Effect of Insulation Projects	16
Effect of Window Projects	16
All-Electric Homes	17
Effect of Fuel-Switching Projects	17
Small Business Results	18
Impact on Greenhouse Gas Emissions	19
Continuing Loan Program Evaluation	20
References	21

Introduction

The Dollar and Energy Saving Loan Program was approved by the U. S. Department of Energy in March 1990, pilot tested, and announced to the general public by the Nebraska Energy Office in July 1990. This program provides low-interest loans to Nebraskans to finance home, building and system energy improvements. Participating lenders provide five percent financing for up to ten years on loans for pre-qualified energy improvement projects. Other energy improvements require an energy audit to determine if they qualify. Loans are available for homes, multi-family dwellings, small businesses and non-profit organizations, farms and ranches, subdivisions of local government, and rural nursing homes. Through June 30, 1994 over 7,200 projects have been funded.

In late January, 1992 the decision was made to implement the first phase of an evaluation to determine how successful the program has been in terms of saving energy and dollars. It was decided that the initial evaluation efforts would be concentrated in the Omaha area. This came about primarily because of the expressed interest of the Metropolitan Utilities District and the Omaha Public Power District of Omaha on the impact of the program on energy consumption. Also of consideration, was the simplified logistics of collecting and evaluating data from a restricted area of the state. To further restrict the scope of the evaluation only those loans approved prior to November 1, 1990 were selected for the initial study. This was necessitated by the fact that loans approved later would not have the necessary energy consumption data available after completion of the loan projects needed for analysis.

Between July 10, 1990 and November 1, 1990, 346 loans were approved in the targeted area. All of these were selected for analysis. With the exception of four loans to small businesses, all were to home owners for residential improvements. A preliminary analysis of this study was presented in September 1992 based on energy consumption for 12 months prior and 12 months after completion of the loan approved projects. Results from that report have been updated with: (a) an additional 12 months energy consumption after completion of loan approved projects, (b) a methodology revision to better reflect weather conditions, (c) more project specific results, and (d) inclusion an assessment of the environmental impact of the loans.

When applying for a loan, each borrower was required to sign a release granting the Nebraska Energy Office access to their utility bills. Without the cooperation and hard work of staff of the Metropolitan Utilities District and the Omaha Public Power District to retrieve the consumption information for these loans, the following analysis would not have been possible. The assistance of these staff members is very much appreciated.

Assumptions and Methodology

Several basic assumptions were made to simplify the analysis. Among these were:

- a) Borrowers were assumed to be rational consumers. That is, they participated in the program because of a need to make the improvements financed through the program. This perceived need is not necessarily related to the improvement in energy efficiency that may result from the improvement. Particularly in the case of window replacements, it may be more important to the borrower that the appearance of their home is improved.
- b) No attempt was made to identify changes other than the specified improvements which may have had an impact on energy consumption. Included in these are: changes in number of family members, additional energy using equipment/appliances, other improvements not financed through the program, and changes in living habits induced by improvements made through the program.
- c) Electricity use was assumed not to be affected by replacement of a natural gas furnace when that was the only project financed.

Processed and logic used to prepare and select the data for analysis include:

- a) Energy consumption data was adjusted to account for differences in weather between the periods of energy consumption being compared.
 - i. All energy consumption data were adjusted to reflect energy consumption in a "normal" year of 6,329 heating degree days (HDD) and 1,170 cooling degree days (CDD).
 - ii. Base level consumption was identified for both the prior and post improvement periods for both electricity and natural gas. Base level consumption is assumed not to be affected by variations in weather conditions. The minimum billed consumption was used as base level consumption.
 - iii. All natural gas consumption above the base level consumption was adjusted for weather.

- iv. All electricity consumption above the base level consumption was adjusted for weather. Consumption billed from May through October was adjusted by cooling degree days. Consumption billed from November through April was adjusted by heating degree days.
 - v. On average, 50% of the natural gas or electricity billed in a particular month is consumed in the prior month. To allow for this in adjusting for weather, 50% of the degree days for the month preceding the first bill were substituted for 50% of the degree days for the month of the 12th bill.
- b) Loans involving projects which fuels were analyzed separately. Projects noted included switching from a propane, fuel oil, or electric furnace to a natural gas furnace; switching from an electric water heater to a natural gas water heater; switching from natural gas air conditioning to electric; switching from natural gas furnace to an electric heat pump; and switching from an electric furnace to a heat pump. Fourteen loans involved fuel switching, but there were not enough in one category to make any meaningful conclusions.
 - c) Loans involving changes in types of electric air conditioners were also analyzed separately. These loans involved replacing a room air conditioner with a central air unit, or installing an air conditioner where none existed before.
 - d) Residential and small business loans are analyzed separately.
 - e) To estimate dollar savings to the home owner, the average unit price paid in the post improvement periods was used. This price is based on the monthly billings which include the minimum service charges, the cost of natural gas or electricity, and any applicable taxes included on the bill. Dollar savings will increase as the price of natural gas or electricity increases. No attempt was made to adjust dollar savings because the energy savings come out of the lowest-priced rate block.
 - f) To estimate the reduction in greenhouse emissions achieved by the loan program, typical Nebraska coefficients were calculated for emissions from sulfur dioxide, nitrogen oxides, and carbon dioxide per kWh of electricity and per therm of natural gas. The coefficients for electricity are based on the average mix of fuels

used to generate electricity in Nebraska during 1991 and 1992.

- g) Loans with missing and/or bad data for all affected fuels have been omitted from the analysis. These primarily resulted from a change in ownership of the property affected by the loan. In addition, a few cases existed where there was an unexplainable monthly billing (usually due to a meter adjustment) which completely invalidated any analysis.

Impact on Natural Gas Consumption

A total of 255 loans were evaluated for their impact on natural gas consumption for the first 12 month period after completion of the loan approved projects. Of the total 346 loans selected for evaluation, 33 consisted of projects which did not effect natural gas consumption, 42 were dropped for bad and/or missing data, 12 involved fuel switching projects, and 4 were to small businesses. An additional 13 loans were dropped from the analysis in the second 12 month period after completion of the loan approved projects, primarily for a change of occupants and the resulting unavailability of appropriate data for analysis.

Evaluation for First 12 Months After Loan Work Completion

Total adjusted natural gas consumption for the 255 residences for the 12 months prior to participation in the Dollar and Energy Savings Loan Program was 314,539 therms at a cost of \$130,801. Total estimated savings was 42,597 therms of natural gas at a cost of \$18,075 annually. On average, these homes consumed 1,233 therms of natural gas prior to program participation and saved 167 therms (or \$71) annually. For these 255 loans, natural gas consumption was reduced 13.54%.

Of these 255 loans, 193 included the replacement of an old natural gas furnace with at least an 80% efficient natural gas furnace as part or all of the work financed by the loan. These homes used on average 1,258 therms of natural gas in the year prior to program participation and saved an average of 196 therms (or \$83) annually. For these 193 loans, natural gas consumption was reduced 15.62%.

The remaining 62 loans which did not include a furnace replacement used on average 1,158 therms of natural gas in the year prior to program participation and saved an average of 75 therms (or \$34) annually. For these 62 loans, natural gas consumption was reduced by 6.48%.

The first year impacts of the loan program on natural gas consumption are summarized in Table 1 below:

Table 1. First Year Average Natural Gas Savings per Loan

Description of Group	No. of Loans	Prior Use	Therms Saved	% Saved	\$ Saved
All loans affecting natural gas	255	1,233	167	13.54	71
Loans including a furnace project	193	1,258	196	15.62	83
Loans without a furnace project	62	1,158	75	6.48	34

**Evaluation for Second 12 Months After Loan Work Completion
and Comparison to First 12 Months**

Total adjusted natural gas consumption for the 242 residences for the 12 months prior to participation in the Dollar and Energy Savings Loan Program was 296,454 therms at a cost of \$123,238. Total estimated savings was 39,859 therms of natural gas at a cost of \$16,915 in the first 12 evaluation months after completion of loan projects. Total estimated savings was 40,623 therms of natural gas at a cost of \$18,545 for the next 12 evaluation months. On average, these homes consumed 1,225 therms of natural gas prior to program participation and saved an average of 165 therms (or \$70) in the first 12 months and an average of 168 therms (or \$77) in the second 12 months. For these 242 loans, natural gas consumption was reduced 13.45% during the first 12 months and 13.70% during the next 12 months after program participation.

Of these 242 loans, 187 included the replacement of an old natural gas furnace with at least an 80% efficient natural gas furnace as part or all of the work financed by the loan. These homes used on average 1,248 therms of natural gas in the year prior to program participation and saved an average of 192 therms (or \$81) in the first 12 months and an average of 193 therms (or \$88) in the second 12 months. For these 187 loans, natural gas consumption was reduced 15.42% during the first 12 months and 15.48% during the next 12 months after program participation.

The remaining 55 loans which did not include a furnace replacement used on average 1,146 therms of natural gas in the year prior to program participation. Estimated savings were 70 therms (or \$32) in the first 12 months and 82 therms (or \$37) in the second 12 months. For these 55 loans, natural gas consumption was reduced 6.13% during the first 12 months and 7.14% during the next 12 months after program participation.

Impacts for the first two years of the loan program on natural gas consumption are summarized in Table 2 below, as well as a comparison of the estimated savings for the two years.

Table 2. First Two Years Average Natural Gas Savings per Loan

Description of Group	No. of Loans	Prior Use	Therms Saved	% Saved	\$ Saved	
All loans affecting natural gas	- year 1	242	1,225	165	13.45	70
	- year 2			168	13.70	77
Loans including a furnace project	- year 1	187	1,248	192	15.42	81
	- year 2			193	15.48	88
Loans without a furnace project	- year 1	55	1,146	70	6.13	32
	- year 2			82	7.14	37

Impact on Electricity Consumption

A total of 225 loans were evaluated for their impact on electricity consumption where the home was also heated by a natural gas, propane, or other non-electric furnace. Of the total 346 loans selected for evaluation, 34 consisted of projects which were assumed not to effect electricity use, 42 were affected by bad and/or missing data, 11 involved fuel switching projects, 6 were all electric homes, 22 added to existing air conditioning equipment, and 4 were loans to small businesses.

(Note: Analysis of savings for electricity is available for only the first 12 months after completion of the loan projects. Extremely cool summer weather during the second 12 months made any meaningful analysis for this period impossible to obtain.)

Total adjusted electricity consumption for the 225 residences prior to participation in the Dollar and Energy Savings Loan Program was 2,684,799 kWh. Total estimated savings was 136,206 kWh annually or \$9,582 in annual electricity costs. On average these homes used 11,932 kWh prior to program participation and saved 605 kWh (or \$43) annually. For these 225 loans, electricity consumption was reduced by 5.07%.

Of these 225 loans, 157 included the replacement of a central air conditioning unit with a more efficient unit as part or all of the work financed by the loan. These homes used an average of 12,251 kWh of electricity in the year prior to program participation and saved an average of 922 kWh (or \$64) annually. For these 157 loans, electricity use was reduced by 7.52%.

The remaining 68 loans which did not include the replacement of a central air conditioning unit used on average 11,197 kWh of electricity in the year prior to program participation and had an average increase in consumption of 125 kWh (or \$7) annually. For

these 68 loans electricity consumption was increased by 1.11%.

In addition, there were 22 loans which involved installation of more air conditioning equipment than was previously in the home. These homes used an average of 9,776 kWh of electricity in the year prior to participation in the Dollar and Energy Saving Loan Program and their electricity use increased an average of 824 kWh (or \$55) annually. This not an unexpected result and due to the efficiency of the equipment installed is probably less of an increase than if the equipment had been installed without the minimum performance requirements of the program.

Six all-electric homes were included in the study group. These homes used an average of 37,529 kWh of electricity in the year prior to program participation and saved an average of 5,112 kWh (or \$288) annually. For these 6 homes, electricity use was reduced an average of 13.62%. Additional detailed information about the impact on all-electric homes is contained in the section pertaining to all-electric homes.

The impacts of the loan program on electricity consumption are summarized in Table 3 below:

Table 3. First Year Average Electricity Savings per Loan

Description of Group	No. of Loans	Prior Use	kWh Saved	% Saved	\$ Saved
All loans affecting electricity that have gas, propane, etc. furnaces	225	11,932	605	5.07	43
Loans that replaced central air conditioning unit	157	12,251	922	7.52	64
Loans that did not replace central air conditioning unit	68	11,197	-125	-1.11	-7
ALSO					
Loans that upgraded central air conditioning equipment	22	9,776	-824	-8.42	-55
All electric homes	6	37,529	5,112	13.62	288

Effect of Gas Furnace Projects

It has already been noted in the "Impact on Natural Gas Consumption" section that 193 of the loans evaluated included the replacement of a natural gas furnace with a more efficient model. Average reduction in natural gas usage was found to be 15.62% during the first 12 months after completion work. Additionally for the 187 loans that were evaluated for 24 months

after completion, savings was 15.42% during the first 12 months and 15.48% during the second 12 months.

There were 22 loans where natural gas furnace replacement was the only project financed. The prior year consumption averaged 1,194 therms of natural gas and savings were an average of 179 therms (or \$77). Natural gas consumption was reduced by 14.99% for these 22 home owners.

Data was available to study savings for 2 years after completion of the work financed by the loan program on 21 homes. These 21 homes averaged 1,186 therms of natural gas consumption in the year prior to the work being completed. Savings in the first year after completion averaged 170 therms (or \$73) and savings in the second year after completion averaged 229 therms (or \$106). Natural gas consumption was reduced by 14.33% in the first year and 19.31% in the second year after completion of the loan projects. *(Note: no reason has been discovered to explain the higher 2nd year savings -- particularly when compared with results in the following paragraphs. It should be noted that some variation in savings from year to year is expected, because of factors not completely accounted for in the evaluation process.)*

There were 84 loans where the only other project was replacement of a room air conditioner with a central air conditioning system or where the central air conditioning system was replaced. Prior year average natural gas consumption was 1,265 therms for these homes. Natural gas consumption was reduced 184 therms (or \$78) annually. Natural gas consumption was reduced 14.55% for these 84 home owners. Assuming that replacement of the air conditioner had no impact on natural gas use, these results are nearly the same as for the group who only replaced their furnaces.

Data was available to study savings for 2 years after completion of the work financed by the loan program on 82 homes. These 82 homes averages 1,249 therms of natural gas consumption in the year prior to the work being completed. Savings in the first year after completion averaged 176 therms (or \$76) and savings in the second year after completion averaged 178 therms (or \$81). Natural gas consumption was reduced by 14.09% in the first year and 14.25% in the second year after completion of the loan projects. Again assuming that replacement of the air conditioner had no impact on natural gas use, these first year results are nearly the same as for those who only replaced their furnaces. Savings between the first and second years are also nearly identical.

There were 4 loans where a furnace replacement was accompanied by only the replacement of a natural gas water heater. These 4 homes had an average prior year consumption of 1,371 therms of natural gas. Savings in the first year after completion averaged 241 therms (or \$101) and savings in the second year averaged 220 therms (or \$99). Natural gas consumption was reduced by 17.58% in the first year and 16.05% in the second year after completion of the loan projects.

Fifteen loans involved furnace, air conditioning system, and water heater replacements. These 15 homes prior natural gas consumption averaged 1,226 therms and showed savings of 225 therms (or \$96). Natural gas consumption was reduced by 18.35%. These results are consistent with the 4 loans with only furnace and water heater replacements.

Data was available to study savings for 2 years after completion of the work financed by the loan program on 14 of these homes. These 14 homes averaged 1,233 therms of natural gas consumption in the year prior to the work being completed. Savings in the first year after completion averaged 226 therms (or \$96) and savings in the second year after completion averaged 256 therms (or \$117). Natural gas consumption was reduced by 18.33% in the first year and 20.76% in the second year after completion of the loan projects. Assuming that the replacement of the air conditioner had no impact on natural gas use, these results are still fairly consistent with the 4 loans with only furnace and water heater replacements.

The impacts of replacement of a natural gas furnace with an energy efficient model are summarized in Tables 4 and 5 below.

Table 4. First Year Average Effect of Replacement of Natural Gas Furnace

Description of Group	No. of Loans	Prior Use	Therms Saved	% Saved	\$ Saved
All loans with natural gas furnace	193	1,258	196	15.62	83
Natural gas furnace only	22	1,194	179	14.99	77
Natural gas furnace and air conditioner	84	1,265	184	14.55	78
Natural gas furnace and water heater	4	1,371	241	17.58	101
Natural gas furnace, air conditioner and water heater	15	1,226	225	18.35	96
Furnace and other (*)	68	1,329	207	15.59	87

* This category includes all loans which included a furnace replacement except for those included in the previous 4 sub-groupings. These loans may also include air conditioning and/or water heater projects as part of the improvements made.

Table 5. First Two Years Average Effect of Replacement of Natural Gas Furnace

Description of Group	No. of Loans	Prior Use	Therms Saved	% Saved	\$ Saved	
All loans with natural gas furnace	- year 1	187	1,248	192	15.42	81
	- year 2			193	15.48	88
Natural gas furnace only	- year 1	21	1,186	170	14.33	73
	- year 2			229	19.31	106
Natural gas furnace and air conditioner	- year 1	82	1,249	176	14.09	76
	- year 2			178	14.25	81
Natural gas furnace and water heater	- year 1	4	1,371	241	17.58	101
	- year 2			220	16.05	99
Natural gas furnace, air conditioner, water heater	- year 1	14	1,233	226	18.33	96
	- year 2			256	20.76	117
Natural gas furnace and other (*)	- year 1	66	1,262	209	16.56	85
	- year 2			185	14.66	84

* This category includes all loans which included a furnace replacement except for those included in the previous 4 sub-groupings. These loans may also include air conditioning and/or water heater projects as part of the improvements made.

In conclusion, natural gas consumption has been reduced by about 15% when a natural gas furnace is replaced with a more efficient model. In addition, replacement of natural gas water heaters with more efficient models reduced natural gas consumption by at least 3%.

Effect of Efficiency of Furnaces Installed

In the above analysis, 187 loans included natural gas furnace replacement projects and adequate data was available to analyze savings for two years after completion of the loan financed work. Of these, 185 loans were studied to determine the effect of furnace efficiency on natural gas consumption. These 185 loans averaged 1,274 therms of natural gas consumption in the year prior to program participation. Savings in the first year after completion of the loan financed projects was 192 therms (or \$81) and savings in the second year were an average of 192 therms (or \$88). Natural gas consumption was reduced by 15.35% in the first year and 15.40% in the second year after completion of the loan projects.

There were 106 loans which financed a furnace rated at an efficiency of 80-83%. These

106 loans averaged 1,204 therms of natural gas use in the year prior to participation in the loan program. Savings in the first year after completion of the loan financed projects was 142 therms (or \$59) and savings in the second year were an average of 146 therms (or \$67). Natural gas consumption was reduced 11.82% in the first year and 12.14% in the second year after completion of the loan projects.

There were 79 loans which financed a furnace rated at an efficiency of 90% or higher. These 79 loans averaged 1,306 therms of natural gas use in the year prior to participation in the loan program. Savings in the first year after completion of the loan financed projects was 258 therms (or \$109) and savings in the second year were an average of 251 therms (or \$114). Natural gas consumption was reduced 19.72% in the first year and 19.42% in the second year after completion of the loan projects.

Analysis of the above 90% efficient furnaces was further subdivided into groups of those furnaces rated 90-92.9% efficient and those rated 93% or more efficient. For those rated 90-92.9% efficient average consumption prior to program participation was 1,317 therms. Savings in the first year after completion of the loan financed projects was 274 therms (or \$116) and in the second year were an average of 269 therms (or \$123). Natural gas consumption was reduced 20.80% in the first year and 20.43% in the second year after completion of the loan projects.

For those rated 93% efficient or higher, average consumption prior to participation was 1,289 therms. Savings in the first year after completion of the loan financed projects was 232 therms (or \$97) and savings in the second year were an average of 231 therms (or \$105). Natural gas consumption was reduced 18.00% in the first year and 17.92% in the second year after completion of the loan projects.

The furnace efficiency results for all loans including a natural gas furnace are summarized in Table 6 below.

Table 6. Effect of Furnace Efficiency, All Loans with Furnace Project

Furnace Efficiency Rating	No. of Loans	Prior Use	Therms Saved	% Saved	\$ Saved	
All Ratings (80.0-96.6%)	- year 1	185	1,274	192	15.35	81
				192	15.40	88
80.0 - 83.0%	- year 1	106	1,204	142	11.82	59
	- year 2			146	12.14	67
90.0 - 96.6%	- year 1	79	1,306	258	19.72	109
	- year 2			251	19.42	114
90.0 - 92.9%	- year 1	48	1,317	274	20.80	116
	- year 2			269	20.43	123
93.0 - 96.6%	- year 1	31	1,289	232	18.00	97
	- year 2			231	17.92	105

A look at the 103 loans which financed a furnace replacement or a furnace and air conditioner replacement only shows prior consumption of 1,222 therms of natural gas. Savings in the first year after completion of the loan financed projects was 176 therms (or \$74) and savings in the second year were an average of 185 therms (or \$85). Natural gas consumption was reduced 14.36% in the first year and 15.11% in the second year after completion of the loan projects.

Of these, 62 loans financed a furnace with a rated efficiency of 80.0 - 83.0%. These 62 loans averaged 1,189 therms of natural gas consumption in the year prior to participation in the loan program. Savings in the first year after completion of the loan financed projects was 142 therms (or \$59) and savings in the second year were an average of 154 therms (or \$71). Natural gas consumption was reduced 11.95% in the first year and 12.92% in the second year after completion of the loan projects.

There were 41 loans which financed a furnace rated at an efficiency of 90% or higher. These 41 loans averaged 1,274 therms of natural gas consumption in the year prior to participation in the loan program. Savings in the first year after completion of the loan financed projects was 226 therms (or \$96) and savings in the second year were an average of 232 therms (or \$106). Natural gas consumption was reduced 17.76% in the first year and 18.19% in the second year after completion of the loan projects.

Analysis of the above 90% efficient furnaces was further subdivided into groups of those furnaces rated 90.0 - 92.9% efficient and those rated 93% or more efficient. For those rates 90.0 - 92.9% efficient, average consumption prior to program participation was 1,260 therms. Savings in the first year after completion of the loan financed projects was 236 therms (or \$101) and in the second year were an average of 231 therms (or \$106). Natural gas consumption was reduced 18.72% in the first year and 18.36% in the second year after completion of the loan projects.

For those rated 93% efficient or higher, average consumption prior to participation was 1,293 therms. Savings in the first year after completion of the loan financed projects was 213 therms (or \$89) and savings in the second year were an average of 232 therms (or \$106). Natural gas consumption was reduced 16.44% in the first year and 17.96% in the second year after completion of the loan projects.

These results are summarized in Table 7 below.

Table 7. Effect of Furnace Efficiency, Loans with only a Furnace Project or a Furnace and Air Conditioner Project

Furnace Efficiency Rating	No. of Loans	Prior Use	Therms Saved	% Saved	\$ Saved
All Ratings (80.0 - 96.6%)	103	1,222	- year 1	14.36	74
			- year 2	15.11	85
80.0 - 83.0%	62	1,189	- year 1	11.95	59
			- year 2	12.92	71
90.0 - 96.6%	41	1,274	- year 1	17.76	96
			- year 2	18.19	106
90.0 - 92.9%	24	1,260	- year 1	18.72	101
			- year 2	18.36	106
93.0 - 96.6%	17	1,293	- year 1	16.44	89
			- year 2	17.96	106

An economic analysis of the above furnace projects indicates that purchasing a 90.0 - 92.9% efficient furnace rather than an 80.0 - 83.0% has a lower life cycle cost and has a simple payback in the 14th year (discounted payback in the 17th year).

Effect of Air Conditioner Projects

It has already been noted in the "Impact on Electricity Consumption" section that 157 of the loans evaluated included the replacement of an electric central air conditioner with a more efficient unit. Average reduction in electricity consumption was found to be 7.52% for these participants in the loan program.

There were 23 loans where the central air conditioner replacement was the only project financed. The prior year consumption averaged 11,778 kWh of electricity and saved an average of 1,265 kWh (or \$88) annually. Electricity consumption was reduced by 10.74% for these 23 home owners.

Replacement of a natural gas furnace was the only other project for 72 loans evaluated. Prior year average electricity consumption was 12,389 kWh for these homes. Electricity consumption was reduced 995 kWh (or \$68) annually. Electricity consumption was reduced by 8.03% for these 72 home owners. These results are somewhat less than when air conditioner replacement was the only project, but remains consistent with those results. One possible explanation is that the replacement furnace is sized more closely to the heating needs of the

house. This means that the blower motor will probably run more during the heating season even though less fuel is consumed, thus reducing the apparent electric savings from the replacement air conditioner.

In an additional 14 loans, both a natural gas furnace and water heater were replaced. These 14 homes had an average prior year consumption of 12,799 kWh and saved an average of 855 kWh (or \$61) annually. Electricity consumption was reduced by 6.68%. It is not known why savings decreased from the previous example.

There were also 12 loans evaluated which financed the replacement of a room air conditioner with a central air conditioner unit and replaced the natural gas furnace. Average prior electricity consumption for these 12 homes was 8,909 kWh. These 12 homes showed an average increase in electricity consumption of 718 kWh (or \$50) annually. Of these, 4 homes showed a decrease in electricity use and 8 showed an increase.

The impacts of replacement of an electric central air conditioner with a more energy efficient model are summarized in Table 8 below.

Table 8. Effect of Replacement of Central Air Conditioner

Description of Group	No. of Loans	Prior Use	kWh Saved	% Saved	\$ Saved
All loans with air conditioner	157	12,251	922	7.52	64
Air conditioner only	23	11,778	1,265	10.74	88
Air conditioner and furnace	72	12,389	995	8.03	68
Air conditioner, furnace, and water heater	14	12,799	855	6.68	61
Air conditioner and other (*)	48	12,111	668	5.51	47
Also,					
Room air conditioner to central air conditioner	12	8,009	-718	-8.96	-50
Those with savings	4	10,066	1,276	12.68	93
Those with increased use	8	-8,331	-1,716	-20.59	-122

* This category includes all loans which included an air conditioner replacement except for those included in the previous 3 sub-groupings. These loans may also include furnace and/or water heater projects as part of the improvements made.

In conclusion, electricity consumption was reduced by nearly 11% when the air conditioner was the only project financed. When furnace and water heater projects are included, savings are reduced. Due to the variety of uses for electricity in the home, electricity consumption has more potential factors affecting its use not accounted for in this study than

natural gas.

It is suspected that the number of room air conditioners removed to install a central air conditioner unit is responsible for the differences in the savings and increased usage groups.

Effect of Insulation Projects

There were 5 loans studied which only involved the financing of an insulation project. The results are quite favorable, but any conclusions should be tempered by the fact that there are only 5 loans in this group. Prior consumption averaged 1,377 therms of natural gas and 11,043 kWh of electricity for the 5 homes. Savings amounted to 245 therms (or \$105) in the first year and 249 therms (or \$112) in the second year for natural gas. Savings in the first year for electricity was 1,406 kWh (or \$106). Natural gas consumption was reduced by 17.79% in the first year, by 18.08% in the second year, and electricity consumption was reduced by 12.74% in the first year.

Effect of Window Projects

There were 25 loans which financed only window replacement projects, of which all 25 were evaluated for effect on electricity consumption and 24 for effect on natural gas consumption. Electricity consumption increased 243 kWh (or \$16) from a prior average consumption of 11,314 kWh. Natural gas consumption decreased by 43 therms (or \$18) from a prior average consumption of 1,106 therms. Therefore, the average homeowner with both a natural gas furnace and an electric air conditioner might see a net annual savings of \$2. It is believed that these results are due to some borrowers having a primary goal of improving the appearance of their home when financing window replacements, rather than improving energy efficiency. Two factors are believed to play a role here:

- a. The windows removed were a combination window and storm window which had more dead air space than the replacement double glazed windows. Thus the new windows could be less energy efficient.
- b. The new windows are more attractive than the ones replaced. Thus drapes may be kept open more often, since windows no longer need to be hidden.

All-Electric Homes

Six loans were made to all-electric homes. The results varied significantly dependent upon the types of improvements made. Two homes which replaced the heating and cooling systems with more efficient units, reduced consumption from an average 48,712 kWh annually by 15,198 kWh (or \$867). Electricity consumption was reduced by 31.20%. Four homes which replaced windows and/or doors reduced consumption from 31,938 kWh annually by 69 kWh (or \$4). These results should be used with caution until additional results from all-electric homes become available.

Effect of Fuel-Switching Projects

Seven loans were made which involved switching from an electric furnace to a natural gas furnace. Three of these loans also included a like switch for the water heater, 4 loans replaced a central air conditioner with a more efficient unit, and 2 loans included window projects. The 7 homes used an average 34,276 kWh (363.3 million Btu @ 10,600 Btu per kWh) prior to participation in the program. During the first year after completion of the loan financed projects these homes used an average 19,723 kWh of electricity and 684 therms of natural gas (277.5 million Btu). This represents a 23.62% reduction in energy use. The annual energy bill was reduced by an average of \$518 for these homes. Electricity consumption was reduced 42.45%.

Two loans were made which involved switching from a natural gas air conditioner to an electric air conditioner. Both also replaced a natural gas furnace with a more efficient natural gas furnace. Electricity consumption increased from an average of 7,798 kWh to 8,999 kWh or by 15.40%. Natural gas consumption decreased from an average of 2,734 therms to 1,717 therms or by 37.21%. Total energy consumption decreased from 356.1 to 267.1 million Btu, a change of 24.99%. The annual energy bill was reduced by an average of \$328 for these homes.

The energy input (on average 10,600 Btu per kWh) to generate and transmit electricity has been used in the evaluation of the above projects. An alternate approach would have been to use the energy received at the home (3,413 Btu per kWh). Either approach results in the same economic result. Using the lower Btu value would result in a net increase in energy consumption for those loans switching from an electric furnace to a natural gas furnace and would increase the net savings for those loans switching from a natural gas air conditioner to an electric one. The approach selected was used because the major interest in energy savings is the energy content of the primary resources saved (coal, nuclear fuel, etc.).

In both of the fuel switching examples, the results should be used with caution due to the small number of loans evaluated in each group.

Small Business Results

The four small business loans evaluated to date were very different in nature and no summary conclusions are possible. As the evaluation is continued, results from additional small business loans will be added to the evaluation. Of the four loans reviewed, the improvements made in 3 of the loans resulted in significant savings in both natural gas and electricity consumption. The fourth business had increased electricity consumption (a lighting project), however, the business was expanded at the same time. A summary of the small business loans and their first year savings is presented in Table 9 below.

Table 9. Small Business Loans.

Business Type and Projects Financed	Energy Source	Prior Use Electricity or Gas	% Saved	\$ Saved
Commercial Building Replace gas furnace (92%) previous also supplemented with electric baseboard heat Replace central air cond. (10 SEER) Install programmable thermostats	gas	9,478	21.06	773
	electricity	400,667	23.21	5824
Commercial Building Insulate ceiling Replace gas furnace (95%) Replace central air cond. (10 SEER)	gas	2,867	32.96	403
	electricity	15,633	33.40	404
Apartment Complex Weatherstrip, caulk patio doors Replace broken windows Install storm doors, windows Replace incandescent with fluorescent lights (outdoor and common areas) Install photocells to control outdoor lighting	gas	43,099	5.64	913
	electricity	70,616	33.75	1927
Clothing Store Replace fluorescent lights with new fluorescent lights and ballasts Expanded operations	electricity	15,048	-28.71	-321

Impact on Greenhouse Gas Emissions

In addition to reducing their energy consumption and thus their energy bills, loan participants are also benefitting society because of the reduction in greenhouse emissions resulting from their reduced energy use. Coefficients to determine the reduction in emissions per 1,000 kWh of electricity and 100 therms of natural gas derived from references 1-3 are summarized in Table 10 below.

Table 10. Greenhouse Gas Emission Coefficients for Nebraska

Factor	Direct Emissions from Natural Gas (pounds per 100 therms)	Indirect Electric Utility Emissions From Fossil Fuels (pounds per 1,000 kWh)
Sulfur Dioxide (SO ₂)	0.0064	4.63
Nitrous Oxides (N ₂ O)	0.9104	7.54
Carbon Dioxide (CO ₂)	1160	1327

Total reduction in greenhouse gas emissions for projects evaluated in the Omaha Area Pilot Study was:

Sulfur Dioxide	1,798 pounds
Nitrous Oxides	3,339 pounds
Carbon Dioxide	520 tons

These results are attributed to 3 commercial loans, the natural gas savings for the 255 residential loans evaluated for natural gas, the electricity savings for 225 residential loans evaluated for electricity, 6 residential loans (all electric homes) evaluated for electricity, and 9 residential loans evaluated for both natural gas and electricity with fuel switching. No attempt has been made to extend emission reductions to those loans dropped from the evaluation for ownership changes, changes in business operations, or lack of meaningful data.

Continuing Loan Program Evaluation

Beginning in November 1992, a sample of all loans made during the preceding quarter (July-September 1992) has been selected quarterly. Results from this first sample are nearing completion on 80 loans. As additional results are obtained, updates on the impact of the Dollar

and Energy Loan Program will be made available on an annual basis. This ongoing evaluation will include more data on commercial loans as well as information on loans from the government, agricultural, and nursing home segments of the program. Information relating to loans having an impact on heating oil, propane, and wood consumption will also be added as the pertinent data becomes available.

References

1. Energy Information Administration, *Electric Power Annual 1992*, DOE/EIA-0348(92), (Washington, DC, January 1994), Tables 12 and 46.
2. Energy Information Administration, *Emissions of Greenhouse Gases in the United States 1985-1990*, DOE/EIA-0573, (Washington, DC, September 1993), Table 11.
3. Energy Information Administration, *Reducing Home Heating and Cooling Costs*, SR/EMEUE/94-01, (Washington, DC, July 1994), Table C5.